

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Post operating instructions.
- B. Manual description.
- C. Submittal requirements.
- D. Submittal of final Operation and Maintenance (O&M) Manuals.
- E. Liquidated damages in regard to O&M Manual submittals.
- F. Off-the-Shelf Equipment Manuals.
- G. Native electronic file format for System Manuals
- H. Format and technical content for System Manuals.
- I. Printed Manual requirements.
- J. Electronic version of Manual (eManual) for System Manuals.
- K. Manual revision control.

1.02 RELATED SECTIONS

- A. Requirements related to spare parts, maintenance materials, keys, special tools, and test equipment are specified in Section 01 78 44, Spare Parts and Maintenance Materials.
- B. Training manuals required for classroom and on-site instruction and training are specified in Section 01 79 00, Demonstration and Training.

1.03 MEASUREMENT AND PAYMENT

- A. Separate measurement or payment will not be made for work required under this Section. All costs in connection with the work specified herein will be considered to be included with the related item of work in the Bid Schedule of the Bid Form, or incidental to the Work.

1.04 REFERENCES

- A. American National Standards Institute (ANSI)
 - 1. ANSI Y14.5 Geometric Dimensioning and Tolerancing Standards

2. ANSI Y32.2 Graphic Symbols for Electrical and Electronics Diagram
- B. BART Facilities Standards, Appendices/District Technical Manuals (BFS Appendix):
1. BFS Appendix Contract Drawing CADD Requirements (available from the Engineer upon request).
 2. BFS Appendix Operation and Maintenance Manual Requirements (available from the Engineer upon request).

1.05 POSTED OPERATING INSTRUCTIONS

- A. Provide, where directed, printed sheets under framed clear acrylic plastic, giving brief, concise operating and maintenance instructions for all items of mechanical and electrical equipment and similar equipment and specialty items, as applicable, at their respective locations.

1.06 OPERATION AND MAINTENANCE MANUAL DESCRIPTION

- A. Manuals shall be provided for all equipment and systems furnished under the Contract that require maintenance, operation, or modification including testing and training equipment. Manuals shall also be provided for other items, such as finishes, when specified in the Contract Specifications. Provide manuals for each item of equipment and its component parts.
- B. Manuals shall be written in English.
- C. Manuals shall be subject to revisions, updates, and other alterations at the District's discretion.
- D. Manuals shall be provided in one of the three following formats:
1. Off-the-Shelf Equipment Manuals shall be provided for off-the-shelf items. Such equipment includes sub-assemblies and components that will be replaced instead of repaired or has no need for modifications, drawings, or manual revisions. Off-the-Shelf Equipment Manuals shall conform to the requirements specified in Articles 1.07, 1.08, 1.09 and 1.10 herein.
 2. System Manuals shall conform to the requirements specified herein. System Manuals shall be provided whenever stipulated in the Contract Specifications. Typically, such systems and equipment will include systems and equipment which have been specifically built for the District and which require repairs and modifications beyond the scope of the manufacturer's pre-existing operation and maintenance instructions. System Manuals shall be BART specific and not include copies of manufacturer's operation and maintenance instructions and catalog cuts. Submit manufacturer's operation and maintenance instructions, if required, separately. System Manuals shall conform to the requirements specified herein with the exception of Article 1.10.

3. Elevators Manuals containing manufacturer's operation and maintenance instructions and catalog cuts are acceptable provided the manuals meet the technical content requirements set forth in Article 1.12 in addition to the requirements specified for Off-the-Shelf Equipment Manuals.
- E. Instructions and manuals from suppliers of District-furnished equipment will be furnished to the Contractor.

1.07 SUBMITTALS

- A. General: Refer to Section 01 33 00, Submittal Procedures, for submittal requirements. Schedule submittal of manuals in coordination with other submittals for the subject system or equipment.
- B. Submit six sets of hard copy originals for review of each draft manual and for District's use of each final approved manual. At the District's discretion, the number of hardcopy originals may be reduced, but shall not be less than three sets. Distribution of manuals will be in accordance with BFS Appendix Operation and Maintenance Manual Requirements.
- C. Concurrently submit electronic files in accordance with requirements in Article 1.08C.
- D. All text, including notes, manufacturer-supplied information such as cut sheets, specifications and other related material shall be clearly legible. All data and text incorporated in illustrations and drawings shall be legible.
- E. Handwritten edits to content is prohibited. Alterations to content shall be legible, noted and detailed explanations reflected in the manual's Appendix.
- F. System Manuals shall be submitted in accordance with the following requirements:
 1. Submit Outline, Complete Draft, and Pre-Final submittals for review before submitting final version.
 - a. Outline – Submit manual layout, sections and headings after final design of system or equipment has been approved.
 - b. Complete Draft – Submit all text and illustrations, sample of binder and electronic files prior to first delivery of system or equipment.
 - c. Pre-Final – Submit complete manual in accordance with criteria specified herein.
 2. Pre-Final O&M Manual Review: Submit for approval prior to final acceptance tests for the particular system or equipment and no later than 42 Days prior to initial training course for District personnel.
 - a. Information gathered during final acceptance testing and training courses shall be incorporated to develop final version of the manual.

- G. Off-The-Shelf Equipment Manuals shall be submitted in accordance with the following requirements:
 - 1. Submit Complete Table of Contents and Complete Draft for review before submitting final version.
 - a. Complete Table of Contents – Submit and obtain approval of the proposed Table of Contents, including volumes, chapter numbers, section titles setup, list of figures, list of tables, list of drawings and warranty information.
 - b. Complete Draft – Submit all text and illustrations, sample of binder and electronic files prior to first delivery of system or equipment.
- H. One set of each manual will be returned to the Contractor, marked with review-stamp-action-block marks as described in Section 01 33 00, Submittal Procedures.
- I. Any non-compliant section of the manual will be identified and communicated to the Contractor in writing by the Engineer.
- J. A manual returned to the Contractor marked “Not Approved” shall be revised and six sets resubmitted to the Engineer for review within 42 Days.
- K. If the Engineer returns a manual to the Contractor that does not require resubmittal, the Contractor will make any noted corrections and submit copies of manual to the Engineer per the requirements of Article 1.08.

1.08 SUBMITTAL OF FINAL OPERATION AND MAINTENANCE MANUALS

- A. Schedule: Submit final manuals no later than 42 Days following the satisfactory completion of Acceptance tests for the subject system or equipment.
- B. The requirements specified in this Article apply to both System and Off-the-Shelf Equipment Manuals.
- C. Electronic submission of each manual in its final form shall include
 - 1. System Manuals: In addition to submittal requirements above, one CD-ROM or USB drive of the electronic version (eManual) containing all native (MS Word) and Adobe (pdf) files required to create the submitted manual. Native and Adobe (pdf) files will be assembled in separate folders.
 - 2. Off-the-Shelf Manuals: One CD-ROM or USB drive of the Adobe (pdf) files used to create the submitted manual.
 - 3. Electronic files shall include a matrix or document showing how the files are set up and how to access them.
 - 4. The content of all files, native or Adobe (pdf), shall be identical to hardcopy manual submitted to District. All manuals shall be submitted as one eManual pdf file, as well as separate pdf files representing each volume and chapter.

5. Extraneous files or information should not be submitted with or incorporated in manuals.

1.09 LIQUIDATED DAMAGES IN REGARD TO O&M MANUAL SUBMITTALS

- A. Failure of Contractor to obtain approval within the required schedule of milestones for manuals will make the Contractor liable for liquidated damages. Milestones and liquidated damages are specified in the Contract Specifications Section 01 11 00, Summary of Work.

1.10 OFF-THE-SHELF EQUIPMENT MANUALS

- A. The Engineer shall provide a book number assigned by the District's Technical Publications unit for each manual. The Contractor shall identify each manual using the assigned book number.
- B. Manuals shall consist of a legible copy of the manufacturer's operating instructions and other operation and maintenance information available from the manufacturer.
- C. Manuals shall include legible copies of manufacturer's catalog cuts with specific items bubbled or clearly marked with arrows.
 1. When it would be clearer to cross-out irrelevant portions of a page, neatly cross-out irrelevant information. Handwritten notes are not accepted. Notes shall be typewritten and inserted into the pdf file or added to the manual's Appendix.
 2. Manuals shall include the following, as applicable and as required by the Engineer:
 - a. Catalog pages.
 - b. Manufacturer's pre-printed maintenance and operations instructions.
 - c. Wiring diagrams.
 - d. Parts lists.
 - e. Warranty slips.
 - f. Manufacturer's certificates, as applicable and as required by the Engineer.
- D. Table of Contents that reflects all volumes, chapters, sections, procedure numbers, list of figures, list of tables, list of drawings, warranty information and corresponding page numbers.
- E. Divide each chapter or section of the manual using divider pages that comply with the requirements.
- F. Manuals for HVAC, Plumbing and Fire Protection equipment shall list the following information:
 1. Equipment identification

2. Make and model
 3. Location of equipment
 4. Filter sizes and quantities
 5. Service and dealer directory including the authorized dealer name, phone number, address, email address, and web site for each piece of equipment.
 6. Valve directory including the valve number, type, size, location and function.
 7. Damper certification and verification.
 8. Domestic water system cleaning and disinfection test results and report.
 9. Air and water system balance reports.
 10. Controls operation and maintenance data with wiring diagrams.
 11. Approved seismic restraint inspection report, certified by professional licensed Seismic Engineer or approved representative.
 12. Warranties: Submit effective date, expiration date, extent of warranty, name and contact information of firm providing warranty.
- G. Binders for each Manual shall comply with the requirements specified in Article 1.13.

1.11 NATIVE ELECTRONIC FILE FORMAT FOR SYSTEM MANUALS

- A. The native electronic file formats are the programs used to create the Operation and Maintenance Manual.
- B. Text pages shall be created using the latest release of MS Word in use by the District at the time of the Contract award, in accordance with BFS Appendix Operation and Maintenance Manual Requirements.
- C. Parts Lists created for Chapter 7, titled "Illustrated Parts Catalog" (all Volumes), shall be created using the latest release of MS Excel in use by the District at the time of the Contract award.
- D. Illustrations and drawings, including technical illustrations, shall be created using AutoCAD 2014 or the latest release in use by the District at the time of Contract award, in accordance with the BFS Appendix Contract Drawings CADD Requirements.
- E. Text pages containing illustrations shall have the AutoCAD files inserted into the MS Word file as an object. AutoCAD files shall have a white background.

1.12 FORMAT AND TECHNICAL CONTENT FOR SYSTEM MANUALS

- A. Each Manual shall meet the following requirements.

1. Developed in conjunction with maintainability requirements.
2. Organized so that each major subsystem is treated as an integrated system and not as a grouping of disassociated parts.
3. Contain data required to maintain equipment during equipment service life.
4. Contain data required to operate and maintain test equipment during equipment service life.
5. Contain no extraneous information, such as general communications, advertisements or company or manufacturer's logos. Any reference to the manufacturer or contractor, other than necessary references to the equipment in the text, is considered advertisement. Manufacturer or contractor's name shall not appear on binder covers or in the page titles, headers, footers or anywhere else in the document.
6. Contain all operating instructions. If required, provide a separate operating manual.
7. Contain drawings and illustrations that include necessary details for the installation, maintenance, and repair of equipment provided.

B. Numbering and Content Minimum Requirements:

1. Obtain a book number assigned by the District's Technical Publications unit for each manual from the Engineer.
2. Each Manual shall be composed of one or more volumes titled and organized by subject matter.
 - a. Each volume may be contained in one or more binders, if necessary, and shall be designated accordingly (i.e. Volume 1A, Volume 1B, Volume 1C, etc.).
 - b. Manuals for complex, multi-component systems may be organized into volumes with each volume covering a subsystem or component of the greater system. Multiple volumes shall be used when specified in the Contract Specifications, when required by the Engineer, or when proposed by the Contractor and accepted by the Engineer.
3. Each volume shall be consecutively numbered (i.e. Volume 1, Volume 2, Volume 3, etc.).

C. Manual (or Volume in the case of multi-volume Manuals) shall contain a Table of Contents and be organized into nine specific chapters as outlined herein.

1. Chapter 1 – General Information and Specification
2. Chapter 2 – Theory of Operation
3. Chapter 3 – Troubleshooting

4. Chapter 4 – Primary Repair
 5. Chapter 5 – Secondary Repair (Component Level)
 6. Chapter 6 – Preventive Maintenance
 7. Chapter 7 – Illustrated Parts Catalog
 8. Chapter 8 – Miscellaneous
 9. Chapter 9 – Wiring Diagrams
- D. Table of Contents shall reflect procedure numbers, figure numbers, tables numbers and corresponding page numbers, as well as the volumes, chapters, and sections of each manual, as applicable. Table of Contents shall list and contain the following:
1. Chapter titles
 2. Section titles
 3. Sub-section titles and corresponding page numbers
 4. List of drawings, including titles, numbers and corresponding page numbers
 5. List of figures, including figure titles, figure numbers and corresponding page numbers
 6. List of tables, including titles, numbers and corresponding page numbers
 7. Procedure numbers and corresponding page numbers
- E. Each chapter shall have a Table of Contents which include the following:
1. Section Titles
 2. Sub-section titles and corresponding page numbers
 3. List of drawings, including titles, numbers and corresponding page numbers
 4. List of figures, including figure titles, figure numbers and corresponding page numbers
 5. List of tables, including titles, numbers and corresponding page numbers
 6. Procedure numbers and corresponding page numbers
- F. Chapters shall comply with the following requirements:
1. Chapter 1 – “General Information and Specifications” shall provide a general overview of the system, including:
 - a. A “List of Acronyms and Abbreviations” in the form of a table.

- b. General non-technical description of equipment, including interface relationships and general functions.
 - c. Pictorial views of the subassembly components and parts described.
 - d. Tables listing the performance specifications of equipment.
- 2. Chapter 2 – “Theory of Operation” shall provide a technically detailed description of equipment, by subsystem, including:
 - a. Location of parts in subassembly or component being discussed.
 - b. Location, function, and operation of pertinent controls, gauges, indicators, and switches.
 - c. Subsystem setup and shutdown procedures.
 - d. Trouble symptoms and first-response diagnostic methods.
 - e. Emergency procedures and safety requirements.
 - f. Electrical wiring diagrams, electronic schematics, and mechanical configurations.
 - g. Block diagrams of provided subsystems, signal flow diagrams, including interface connections to other subsystems.
 - h. Applicable charts, figures and drawings to be located at the end of text for each subsystem.
- 3. Chapter 3 – “Troubleshooting” shall contain:
 - a. Necessary information for troubleshooting and fault isolation.
 - b. Charts and tables as applicable listing symptoms, probable causes of improper operation or failure of subsystem and probable remedies.
- 4. Chapter 4 – “Primary Repair” shall contain the following information to allow maintenance to be performed at equipment location site:
 - a. Detailed corrective maintenance procedures to be performed on equipment shall include particulars on testing alignment, adjustment and tuning. Include detailed views of mechanical parts or schematics for tests.
 - b. Step-by step procedures of installation and removal of components and subassemblies (field replaceable units).
 - c. Procedures for use of special test equipment.
 - d. Warning and caution notes as required.
 - e. Applicable charts, figures, and drawings to be located at the end of text for each subsystem.
- 5. Chapter 5 – “Secondary (Component) Repair”, shall contain the following in regard to maintenance to be performed in a shop other than the equipment location site:

- a. Detailed corrective maintenance procedure to be performed on subassemblies and components shall include particulars on testing alignment and tuning. Include detailed views of mechanical parts or schematics.
 - b. Step-by-step procedures for installation and removal of parts in assemblies and components.
 - c. Procedures for use of special test equipment.
 - d. Incorporate warning and caution notes, as required.
 - e. Applicable charts, figures and drawings to be located at the end of text for each subsystem.
6. Chapter 6 – “Preventive Maintenance”, shall contain:
 - a. Preventive maintenance procedures, schedules, and tables including lubrication requirements and frequency of application.
 - b. Inspection and maintenance standards, including wear limits, settings, tolerances, and criticality of tolerances.
 - c. Storage instructions for spare parts, special tools and test equipment.
7. Chapter 7 – “Illustrated Parts Catalog”, shall contain:
 - a. Instructions for use of Illustrated Parts Catalog.
 - b. Index by subassembly.
 - c. Illustrations which are exploded views of assemblies, components, and parts with leader lines and circled callout numbers to each item.
 - d. Detailed Parts List, including:
 - 1) Figure Number.
 - 2) Part index number, not to exceed 19 alphanumeric characters.
 - 3) Space to allow for insertion of the District’s nine-digit stock number (group, subgroup, part number).
 - 4) Description of part, including manufacturers and vendor’s part number.
 - 5) Equivalent parts available from other manufacturers.
 - 6) Disposition of part (repairable, non-repairable, etc.).
 - 7) Quantity required per assembly.
8. Chapter 8 – “Miscellaneous”, shall contain information that is deemed inappropriate for any other chapter including descriptive brochures, manufacturer’s certificates and warranty slips.
9. Chapter 9 – “Wiring Diagrams”, shall contain:
 - a. Applicable electrical, electronic, pneumatic, and schematic diagrams.

- b. Wiring diagrams, including wire color code, size, and rating; terminal and connector pin numbers; and plug and socket numbers.
- c. Pin-to-pin description of each wire, using wire-marking format. Additionally, wires at each terminal block and each connector shall be independently identified and cross-referenced at the next terminating point.
- d. Diagram size in accordance with that previously stated in these specifications.
- e. PCB layout diagrams (artwork) for non-standard and non off-the-shelf printed circuit (PC) boards.

G. Front Cover Page Specifications

- 1. The Engineer will provide artwork for the front cover page. Front cover page shall be in accordance to BFS Appendix Operation and Maintenance Manual Requirements.

H. Paper, Page Layout and Page Numbers

- 1. Paper, Page Layout and Page Numbers shall be in accordance to BFS Appendix Operation and Maintenance Manual Requirements

I. Technical Illustrations:

- 1. Draw illustrations, including “exploded” views and illustrated part breakdowns. Use illustrations to facilitate descriptions of assemblies and the relationships of components, subsystems, and systems. Illustrations shall conform to the requirements and the recommendations of referenced ANSI Standards.
- 2. Technical illustrations shall comply with the following requirements:
 - a. Illustrations shall include details necessary for the installation, maintenance and repair of all equipment provided. Details shall be readable.
 - b. Each illustration shall be designated as a “figure”. The word “Figure,” accompanying numerical designation and caption shall be the same size, style, and type as the written text. Its physical location shall be the same on each page.
 - c. Figure numbers and descriptions of figures shall be readable in the horizontal position as you read the page from left to right.
 - d. Figures containing graphics, illustrations, diagrams, and similar drawings, shall be readable and appear at the end of the applicable section or procedure.
 - e. Whenever callout numbers are used in an illustration, they shall be circled and readable.
 - f. Graphic symbols used for electrical and electronics shall conform to ANSI Y32.2. All symbols shall be readable.

- g. Graphic symbols used for logic diagrams shall conform to ANSI Y14.5. All symbols shall be readable.
- h. Drawing file and drafting requirements including line convention and lettering shall conform to the BFS Appendix Contract Drawing CADD Requirements.

J. Revisions to Text and Drawings:

- 1. Revisions shall be made for design changes, retrofits, and errors as required, and based upon changes generated during testing. These revisions shall be listed on a List of Effective Pages to be issued with each review submittal and revision of the manuals until expiration of the Contract.
- 2. Include at the beginning of each completed manual or volume, a Configuration Control Record form adhering to the format provided by the Engineer. Form shall include columns for the chapter, page number, revision date, and revision description.
- 3. Refer to Article 1.15 entitled "Manual Revision Control" herein for revision requirements applicable to revisions to final draft and approved manuals.

1.13 PRINTED MANUAL REQUIREMENTS

A. Binder Specifications:

- 1. The Engineer will provide artwork for front cover and spine.
 - a. Artwork for front cover will include the project name, title of the manual, book number, and volume number if warranted. Artwork will also include "San Francisco Bay Area Rapid Transit District, 300 Lakeside Drive, Oakland, California 94612" printed in the lower center of the cover.
 - b. Artwork for the spine will include the project name, title of the manual and book number.
 - c. Cover and spine shall be printed on white cardstock paper in accordance to BFS Appendix Operation and Maintenance Manual Requirements.
- 2. Divider Page Specifications: Each chapter including the Table of Contents shall have divider tabs in accordance to BFS Appendix Operation and Maintenance Manual Requirements.

B. Final Assembly: All hard copies shall be printed out, assembled, and placed in binders in accordance to BFS Appendix Operation and Maintenance Manual Requirements.

C. The first section for each volume or book shall contain the cover sheet for that volume/book, the BART Configuration Control Record for that volume/book and the master Table of Contents listing all of the chapters for the entire volume/book. When a volume is contained in more than one binder, each binder shall include a cover sheet, and master Table of Contents for the entire volume/book in accordance to BFS Appendix Operation and Maintenance Manual Requirements.

1.14 ELECTRONIC VERSION OF MANUAL (eMANUAL) FOR SYSTEM MANUALS

- A. The eManual shall be created from the native electronic files, as specified in Article 1.11, herein, using Adobe Acrobat, (latest release in use by the District) and in accordance to BFS Appendix Operation and Maintenance Manual Requirements.

1.15 MANUAL REVISION CONTROL

- A. Revisions of final draft and approved Manuals shall be listed on a Configuration Control Record form in the front of each Manual, in accordance to BFS Appendix Operation and Maintenance Manual Requirements.
1. Contractor shall maintain updated lists and revisions in the Manuals until the warranty period expires. Revisions shall be prepared prior to the arrival of altered components, and as soon as possible after procedures are changed or errors are found.
 2. Contractor shall provide revisions to the approved Manuals on a not less than quarterly basis during the first 12 months after the final Manuals are delivered, and then on a not less than semi-annual basis for the duration of the warranty period.
 3. Contractor shall issue revisions related to major alterations of principal subsystems or assemblies prior to the arrival of components.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION 01 78 23